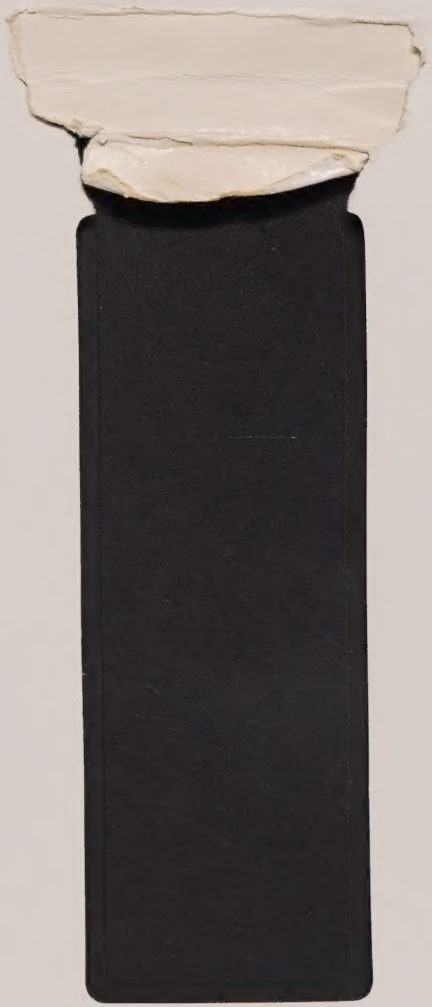
INSTRUCTION MANUAL

PRELIMINARY

OPTION 55T

FOR MODEL 5001

RACAL-DANA



PUBLICATION NO. 980568

PRELIMINARY

OPTION 55T

FOR MODEL 5001

RACAL-DANA

RACAL-DANA INSTRUMENTS INC.
18912 Von Karman Ave., Irvine, CA 92715
Telephone: 714/833-1234, TWX: 910-595-1136, TLX: 67-8341

RACAL-DANA INSTRUMENTS LTD.
Duke Street, Windsor, Berkshire SL4 1SB, United Kingdom
Telephone: Windsor (07535) 69811, TLX: 847013

RACAL-DANA INSTRUMENTS S.A.
18 Avenue Dutartre, 78150 Le Chesnay, France
Telephone: (3) 955-8888, TLX: 697 215

RACAL-DANA INSTRUMENTS, LTD., DEUTSCHLAND
Hermannstrasse 29, D-6078 Neu Isenburg, Federal Republic of Germany
Telephone: 06102-2861/2, TLX: 412896

MP MASTER
MA25719

RACAL

PUBLICATION DATE: JANUARY 1982

Copyright © 1982 by Racal-Dana Instruments, Inc. Printed in the United States of America. All rights reserved.
This book or parts thereof may not be reproduced in any form without written permission of the publishers.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07307

WARRANTY

Within one year of purchase, Racal-Dana will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship. All parts and labor charges will be paid by Racal-Dana Instruments. Just call Racal-Dana Product Service at (714) 833-1234 in U.S.A., Windsor (07535) 69811 in England, 027-7575 in France, or 06102-2861/2 in Germany for assistance. We will advise you the proper shipping address for your prepaid shipment. Your instrument will be returned to you freight prepaid.

PROPRIETARY NOTICE

This document and the technical data herein disclosed, are proprietary to Racal-Dana Instruments, Inc., and shall not, without express written permission of Racal-Dana Instruments, Inc., be used, in whole or in part to solicit quotations from a competitive source or used for manufacture by anyone other than Racal-Dana Instruments, Inc. The information herein has been developed at private expense, and may only be used for operation and maintenance reference purposes or for purposes of engineering evaluation and incorporation into technical specifications and other documents which specify procurement of products from Racal-Dana Instruments, Inc.

FOR YOUR SAFETY

Before undertaking any maintenance procedure, whether it be a specific troubleshooting or maintenance procedure described herein or an exploratory procedure aimed at determining whether there has been a malfunction, read the applicable section of this manual and note carefully the WARNING and CAUTION notices contained therein.

The equipment described in this manual contains voltage hazardous to human life and safety and which is capable of inflicting personal injury. The cautionary and warning notes are included in this manual to alert operator and maintenance personnel to the electrical hazards and thus prevent personal injury and damage to equipment.

If this instrument is to be powered from the AC line (mains) through an autotransformer (such as a Variac or equivalent) ensure that the common connector is connected to the neutral (earthed pole) of the power supply.

Before operating the unit ensure that the protective conductor (green wire) is connected to the ground (earth) protective conductor of the power outlet. Do not defeat the protective feature of the third protective conductor in the power cord by using a two conductor extension cord or a three-prong/two-prong adapter.

Maintenance and calibration procedures contained in this manual sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures carefully and heed Warnings to avoid "live" circuit points to ensure your personal safety.

Before operating this instrument.

1. Ensure that the instrument is configured to operate on the voltage available at the power source. See Installation section.
2. Ensure that the proper fuse is in place in the instrument for the power source on which the instrument is to be operated.
3. Ensure that all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If at any time the instrument:

- Fails to operate satisfactorily
- Shows visible damage
- Has been stored under unfavorable conditions
- Has sustained stress

It should not be used until the performance has been checked by qualified personnel.

TABLE OF CONTENTS

Section	Title	Page
1	**GENERAL DESCRIPTION**	1-1
1.1	Purpose	1-1
1.2	Scope	1-1
1.3	Product Support Group	1-1
1.4	Option 55T Interface	1-1
1.5	Change Notices	1-1
1.6	Specifications	1-1
2	**INSTALLATION**	2-1
2.1	Option 55T Interface Installation	2-1
2.2	Option 55T Unpacking and Inspection Instructions	2-1
2.3	Option 55T - Preliminary Installation	2-1
2.4	Option 55T Circuit Board Installation	2-3
2.5	Option 55T Installation Testing	2-5
2.6	Option 55T Installation Troubleshooting	2-6
3	**OPERATION**	3-1
3.1	Introduction	3-1
3.2	Operation	3-1
3.3	General Purpose Interface Bus (GPIB)	3-1
3.3.3	Option 55T Description	3-1
3.3.3.3	Data	3-2
3.3.3.4	Handshake Operation	3-2
3.3.3.5	Interface Lines	3-5
3.3.4	Option 55T Address Assignment	3-5
3.3.5	Option 55T Operating Sequence	3-6
3.3.6	Interface Message Repertoire	3-9
3.3.6.4	Selected Device Clear (SDC)	3-10
3.3.6.5	Group Execute Trigger (GET)	3-10
3.3.6.6	Device Clear (DCL)	3-10
3.3.6.7	Unlisten (UNL)	3-10
3.3.6.8	Untalk (UNT)	3-10
3.3.7	Device-Dependent Messages	3-11
3.3.7.2	Trigger Commands	3-11
3.3.7.3	Format Commands	3-13
3.3.7.4	Terminator	3-13
6	**DRAWINGS**	6-1
7	**PARTS LIST**	7-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
2.1	Overall View - GPIB Option 55T (Installed)	2-2
2.2	Top Cover Removal	2-3
2.3	Connector Cable P3 Positioning	2-3
2.4	P3/J3 Orientation with Insert Lateral View	2-4
2.5	Connector Cable P2 Orientation	2-4
2.6	PCB Support Plate Installation	2-5
2.7	Mounting Standoff Insertion/U11 IC Heatsink Attachment	2-5
3.1	IEEE-488 Connector (5001 Rear Panel)	3-1
3.2	Interface Signal Pin Assignments	3-2
3.3	Handshake Flow Chart	3-3
3.4	Handshake Timing	3-8
3.5	Input Signal Magnitude at 5001 Terminals	3-12

LIST OF TABLES

Table	Title	Page
1.1	General Specifications	1-2
2.1	Troubleshooting Table	2-6
3.1	Instrument Address Selector	3-4
3.2	Bus Operation Sequence	3-7
3.3	Interface Used With the 5001	3-10
3.4	Option 55T Trigger Commands	3-11
3.5	Hold-with-Delay Commands Required to Compensate for 5001 Settling Times	3-12
3.6	Option 55T Format Commands	3-13
3.7	Optional Command String Terminator	3-13

SECTION 1 GENERAL DESCRIPTION

1.1 PURPOSE.

1.1.1 Racal-Dana Instruments prepared this Instruction Manual for the GPIB Option 55T which is designed for use with the Model 5001 Digital Multimeter (DMM). It is strongly recommended that users and technicians read this manual before installing the option or operating the 5001/55T system.

1.2 SCOPE.

1.2.1 The Option 55T Instruction Manual includes information for qualified technical personnel regarding the installation and operation of the option with the 5001 DMM. Also provided are a Table of Specifications, Schematics and a Parts List. An installation Troubleshooting Table will be found at the end of Section Two.

1.3 PRODUCT SUPPORT GROUP.

1.3.1 The Racal-Dana Irvine complex maintains a complete engineering laboratory, field engineers, service department and parts department to support the product committment. Further support is provided by a network of area field representatives and service centers. The complete list appears on the last two pages of the manual. The warranty program declaration is presented in the Foreword of this manual; also, service personnel are available for service consultation.

1.4 OPTION 55T INTERFACE.

1.4.1 The Option 55T is an IEEE-Standard-488-1978 bus that provides the logic and control functions necessary to interface the 5001 DMM within an instrument system. It is designed to be ordered separately from the 5001 and field installed. The combination of the 55T and its host 5001 can operate in either the "Talk Only," or "Basic Talker" mode. As a Listener, Option 55T will handshake incoming characters; but can be programmed only in the trigger mode with neither function nor range being programmable.

1.5 CHANGE NOTICES.

1.5.1 Improvements or changes to the equipment which occur after printing of this Instruction Manual will be explained on a Change Notice Sheet in the front of the manual after the safety notice.

1.6 SPECIFICATIONS.

1.6.1 Detailed specifications for Option 55T are listed in Table 1.1 These specifications are defined as the performance standards or limits against which the Option 55T is tested.

Table 1.1 - Specifications

GENERAL	
Power Requirements	AC Power derived from 5001: All voltage, power and frequency specifications from the 5001 Instruction Manual apply to the 5001/55T combination.
Weight	0.45 Kg (1 lb.)
Dimensions:	17.5 cm X 19.0 cm X 3.2 cm. (6.9" X 7.5" X 1.25")
Warranty:	1 year
Temperature Range: Operating Storage	 0°C to 50°C −40°C to + 70°C
Fuse:	Located on 5001 motherboard.
Read Rate:	Same as 5001

PROGRAMMING REQUIREMENTS
1) Character Code: 7 bit ASCII, upper or lower case.
2) All Program Strings transmitted to the 5001/55T should end in a terminating character.
Acceptable terminators are:
C R Carriage Return
L F Line Feed
At least one of the above terminators is required at the end of every Program String.

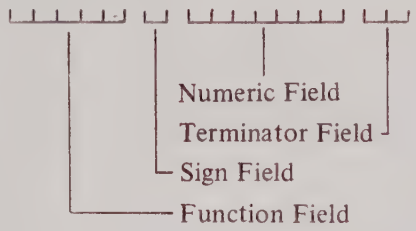
COMPLIANCE TO IEEE-488-1978: SUBSET CAPABILITY		
GPIB Subset	**Description**	**Applicable Capability**
SH1	Source Handshake	Complete Capability
AH1	Acceptor Handshake	Complete Capability
T7	Talker	Complete Except Serial Poll 1) Basic Talker 2) Talk Only Mode 3) Unaddress if MLA
L4	Listener	Complete Except Listen Only 1) Basic Listener 2) Unaddress if MTA
SR0	Service Request	No Capability
RL0	Remote/Local	No Capability
PP0	Parallel Poll	No Capability
DC1	Device Clear	Complete Capability 1) DCL−Device Clear 2) SDC−Selected Device Clear
DT1	Device Trigger	Complete Capability GET−Group Execute Trigger
C0	Controller	No Capability
E1	Open Collector Bus Drivers	

HANDSHAKE TIMES (TYPICAL)	
1) **Interface Messages**	0.4 ms
2) **Device Commands**	0.6 ms/byte
3) **Output Reading (15 bytes)**	0.3 ms/byte

Table 1.1 - Specifications *(Continued)*

DATA OUTPUT FORMAT

Standard Output:



Function Field:

1) "VDC_ _ "
2) "VAC_ _ "
3) " kohm_ "
4) "DCmA_ "
5) "ACmA_ "
6) "% _ _ _ _ "
7) "rdgs_"
8) " _ _ _ _ _ " 5 spaces
see "F0" command

Sign Field:

1) Space represents positive
2) "—" represents negative.

Numeric Field:

RANGE	FIELD CONTENTS
.1	.DDDDDD
1	D.DDDDD
10	DD.DDDD
100	DDD.DDD
1,000	DDDD.DD
10,000	DDDDD.D
.1mA	.DDDDD_
1mA	D.DDDD_
10mA	DD.DDD_
100mA	DDD.DD_
1,000mA	DDDD.D_
> 22MΩ	DDDDD._

NOTE: "_" represents a space

Overload Output: 9999999 in numeric field.

DATA OUTPUT FORMAT *(Continued)*

Terminator Field:

	Conditions	Terminator	
1)	Talk-only mode with address previously set to 30	_	L F
2)	All other conditions	C R	L F

NOTE: "_" represents a space

SECTION 2 INSTALLATION

2.1 OPTION 55T INTERFACE INSTALLATION

NOTE

Installation should be performed by qualified service personnel only, and not by technically-unqualified individuals.

2.1.1 Refer to all illustrations when referenced in the installation instructions; an overall view of the 5001 with the 55T option in place (Figure 2.1) is provided on page 2-2.

2.2 OPTION 55T UNPACKING AND INSPECTION INSTRUCTIONS

NOTE

If the 5001 and Option 55T are received separately, it is important to power-up the 5001 unit first to verify its normal operation BEFORE installing the 55T. After depressing the POWER switch, normally the 5001 will momentarily light all LED's followed by the model number (5001). Then, a few seconds later, readings will be displayed. If power-up of the 5001 is not normal, troubleshoot and correct any problem with the 5001 before installing the 55T.

2.2.1 Option 55T is shipped separately from the 5001. Upon receipt and prior to unpacking the option, examine the exterior of the shipping package for any obvious signs of physical damage (all irregularities should be noted on the shipping invoice). Carefully remove the 55T option assembly and associated mounting and fastening hardware from the plastic foam packaging. The 55T circuit board assembly itself is inside an electrically conductive packaging for protection of static sensitive components.

CAUTION

Because MOS devices are electrostatically sensitive, the installer of Option 55T must be properly grounded in a static-free work area or station while handling and installing the 55T printed circuit board assembly.

Inspect the printed circuit board assembly for evidence of damage. Notify the carrier immediately if any damage is apparent. When there is questionable damage, only a qualified service person should check the 55T option for sale and reliable operation.

2.2.2 The Option 55T assembly package includes the following parts. Check and ensure that all parts are present before proceeding with installation.

a) 1 GPIB printed circuit board assembly (P/N 401681)
b) 1 PCB support plate (P/N 454589).
c) 2 phillips pan-head screws #4-40 X .312 (P/N 615043)
d) 1 phillips pan-head screw #6-32 X .437 (P/N 615060)
e) 1 split lockwasher, #4 stainless steel (P/N 617127)
f) 1 hardware kit including 2 metric mounting standoffs (P/N 630011)

NOTE

If the metric standoffs are packaged in a bag labeled "Champ Connector Accessory Kit," open the bag and discard all hardware except the two metric standoffs.

g) 1 preliminary instruction manual for Option 55T (P/N 980568)

2.2.3 The following basic tools are required for installation of the Option 55T:

a) #1 phillips screwdriver
b) #2 phillips screwdriver
c) 9/32 inch nut driver

2.3 OPTION 55T - PRELIMINARY INSTALLATION

2.3.1 Disconnect the power cord of the 5001 DMM from the AC power source.

WARNING

Removal of covers from the 5001 exposes potentially lethal voltages. Avoid contact with internal electrical connections while the 5001 is connected to the AC power source.

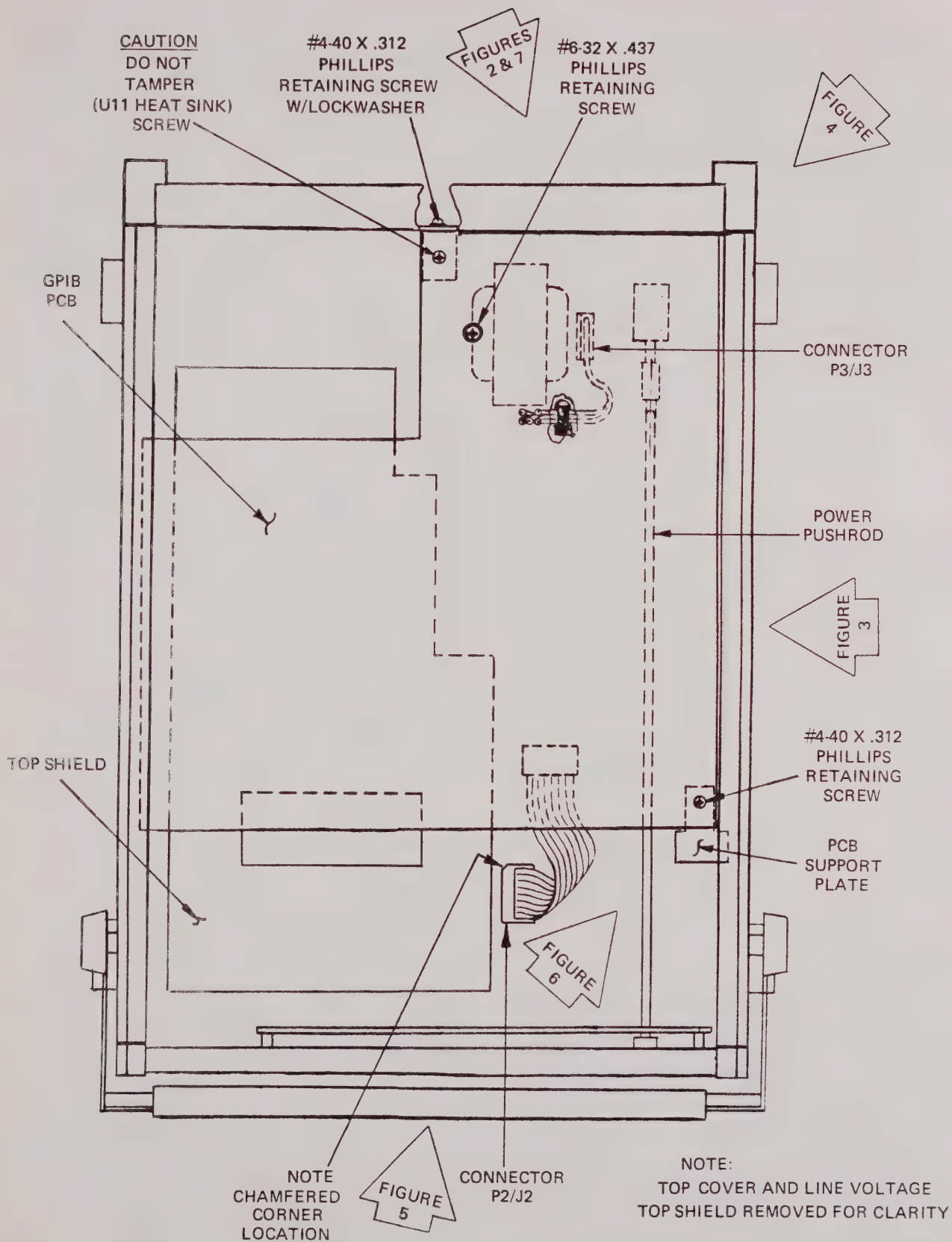


Figure 2.1 – Overall View – GPIB Option 55T (Installed)

2.3.2 Refer to Figure 2.2 to complete this step. Remove the instrument top cover by first loosening the two rear corner feet.

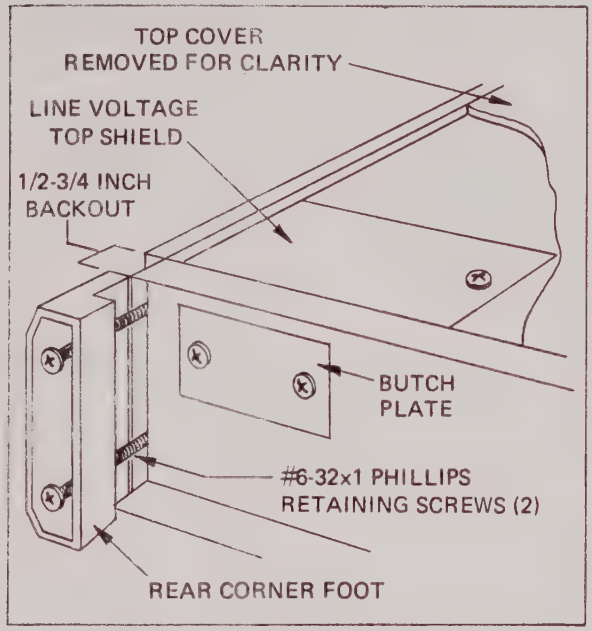


Figure 2.2 - Top Cover Removal

NOTE

It is **NOT** necessary to remove either of the two rear corner-feet or any of their retaining screws to remove the instrument top.

a) Loosen and unscrew the two phillips-head retaining screws from each corner-foot.

b) Back out each screw between 1/2 and 3/4 inch.

c) With the two rear corner-feet now loosened, slide the top cover 1/2 inch toward the rear of the unit. Lift the cover off and set it aside for later re-installation

2.3.3 Refer to Figure 2.2. After the top cover has been removed, disassemble and remove the plastic line voltage top shield.

a) Unscrew, remove and discard the one #6-32 X .250 phillips-head retaining screw from the top shield.

b) Lift out the top shield and retain for later reinstallation.

NOTE

The retaining screw must be discarded after removal as a new part is supplied with the option.

2.3.4 Refer to Figure 2.2. Next remove the butch plate and its mounting hardware from the rear panel to permit insertion and mounting of the GPIB connector. This mounting hardware should be retained in case the Option 55T is removed from the 5001 at some future time.

2.4 OPTION 55T CIRCUIT BOARD INSTALLATION.

2.4.1 Refer to Figures 2.3 and 2.4. Position and route connector cable P3 to avoid all interference with the AC power pushrod and the guard shield for transformer T1 on the motherboard. This can be efficiently performed by (1) keeping the cable against the 55T transformer as much as possible during the procedure, (2) positioning cable P3 directly over its junction terminal J3 prior to actual insertion, (3) keeping the thin wall of P3 facing the 55T transformer, and, finally, (4) visually checking the clearance and position of cable P3 through the upper right vent on the right side panel.

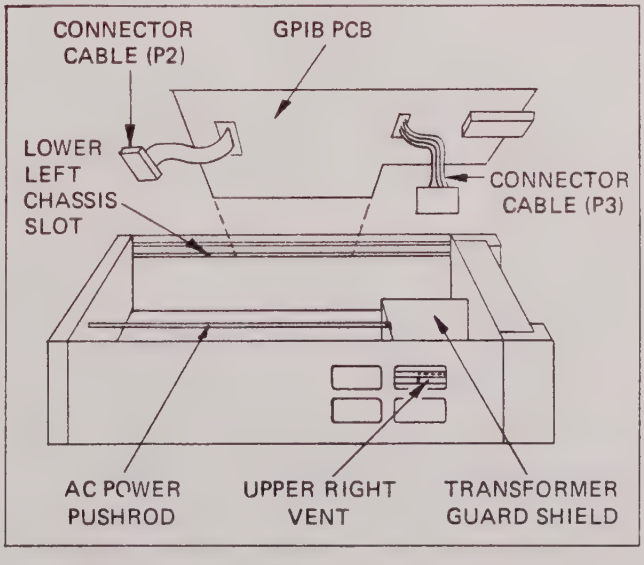


Figure 2.3 - Connector Cable P3 Positioning

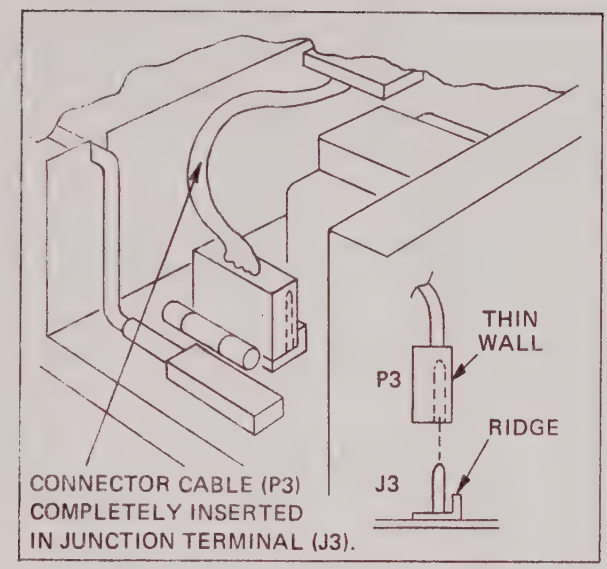


Figure 2.4 - P3/J3 Orientation with Insert Lateral View

CAUTION

Improper positioning of the connector cable P3 against the AC power pushrod and transformer (T1) guard shield may eventually cause fraying of the insulation of cable P3.

2.4.2 Insert connector cable P3 completely into junction terminal J3.

CAUTION

Refer to Figure 2.4. Before connecting P3 and J3, ensure that the polarity of the connector is correct. This requires that P3 be properly oriented for insertion onto J3 with the thin wall of P3 against the ridge of J3.

2.4.3 Refer to Figure 2.3 in completing this step. For purposes of description, the left and right sides of the 5001 chassis are those referenced when one is facing the front panel. Carefully insert the printed circuit board into the lower (and thinner) inside slot on the left side panel of the 5001 chassis.

2.4.4 Check for any bent pins on the P2 connector.

2.4.5 Then, position the P2 connector so that its chamfered corner is facing the left rear corner of the unit on the left side of the 5001 chassis.

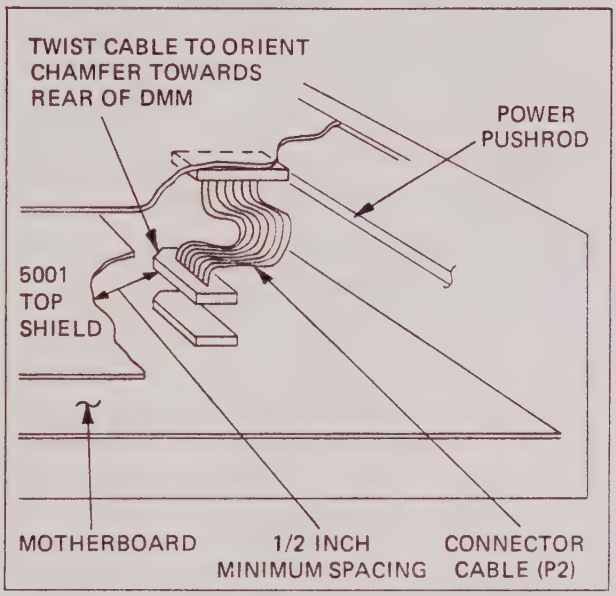


Figure 2.5 - Connector Cable P2 Orientation

2.4.6 Refer to Figure 2.5. Ensure that connector cable P2 is routed to maintain at least 1/2 inch spacing from the 5001 top shield and the AC power pushrod. Insert connector cable P2 completely into junction terminal J2.

CAUTION

The P2 connector could be engaged with one pin pair uninserted. Ensure that all sixteen pins of the connector are inserted before continuing the installation procedure.

2.4.7 Slide the 55T circuit board approximately 1/2 inch toward the rear of the 5001 chassis. The J201 connector should now protrude through the rear panel port for the 55T option.

2.4.8 Refer to Figure 2.1. While firmly holding the 55T circuit board against the rear panel, insert the 55T PCB Support plate into the lower inside slot on the right side panel of the 5001 chassis. Align the screw holes for fastening.

2.4.9 Refer to Figure 2.6. Insert the #4-40 X .312 phillips-head screw; then turn it to hand-tightness.

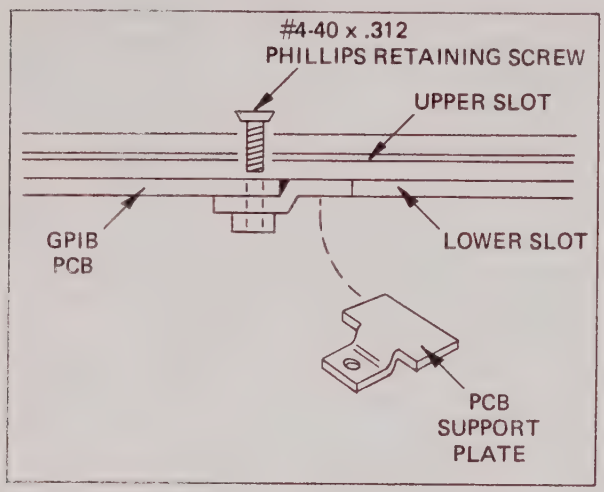


Figure 2.6 - PCB Support Plate Installation

2.4.10 Refer to Figure 2.7. Assemble and initially finger-tighten the two metric hex-headed mounting standoffs on each side of the J201 GPIB connector using the 9/32 inch nut driver.

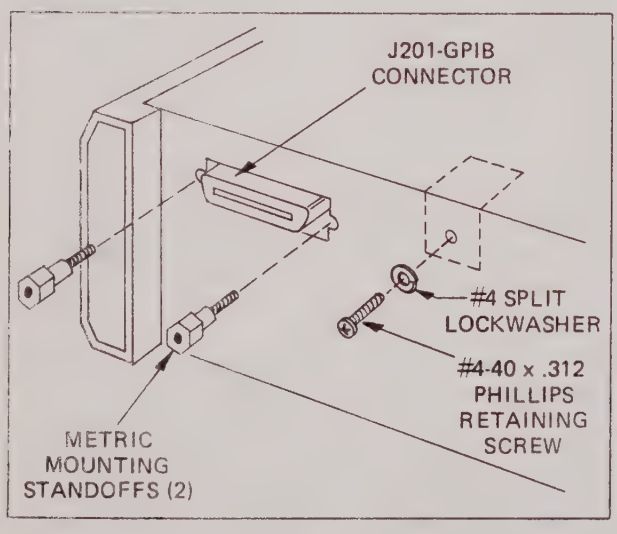


Figure 2.7 - Mounting Standoff Insertion/U11 IC Heatsink Attachment

CAUTION

Do **NOT** tamper with the circuit board retaining screw for the U11 heat sink when inserting the mounting standoffs. See Figure 2.1.

2.4.11 Refer to Figure 2.7. Attach the heatsink for the U11 integrated circuit to the rear panel to hand-tightness using the #4-40 X .312 phillips-head screw and #4 lockwasher.

2.4.12 Complete final tightening of each standoff using the 9/32 inch nut driver.

2.4.13 Reinstall the plastic line voltage top shield as follows:

a) Insert the top shield into the inside upper slot of the right side panel.

b) Align the screw holes and fasten the top shield to hand-tightness using the #6-32 X .437 phillips-head screw.

WARNING

Do **NOT** turn on the 5001 without the plastic line voltage top shield reinstalled.

2.5 OPTION 55T INSTALLATION TESTING

2.5.1 Before reinstalling the top cover of the 5001, a simple operator test must be carried out to partially verify that correct installation of Option 55T has been completed. Essentially the test sequence involves a power-up procedure as follows:

a) After ensuring that the line voltage selector is in the proper position, connect the power cord to the AC outlet (check the line voltage selector card P4 through the opening on the rear panel).

b) Depress the POWER switch to power-up the 5001.

c) Momentarily, a 7-segment display of red LED's (8's) should show on the front panel.

d) Next, the model number (5001) should be displayed followed by the digital read-out "ton" or "Addr" plus two digits (i.e."AddrXX").

2.5.2 If the unit does not perform as described, refer to paragraph 2.6 below.

2.5.3 Assuming the operator test for installation of Option 55T is satisfactory, complete reassembly of the 5001 as follows:

a) Disconnect the power cord from the AC outlet.

b) Replace the top cover on the chassis frame with the side flanges correctly fitted into the frame grooves and the front end of the top cover about one inch from the front panel.

c) After correctly seating the top cover, slide it forwards until its front edge slides under the front panel.

d) Retighten to hand-tightness the two phillips-head retaining screws for each of the two rear corner-feet.

2.5.4 The 5001 DMM with Option 55T is now ready for operation. Please read the entire set of operating instructions provided in the next section before actually operating the 5001.

2.6 INSTALLATION TROUBLESHOOTING

2.6.1 If the 5001 fails to power-up as described in steps (c) and (d) of paragraph 2.5.1, consult the following table.

Table 2.1 - Troubleshooting Table

Symptom	Possible Problem	Corrective Procedure
5001 fails to display all 8's followed by one of the following: "5001" or "Error 4"	Option 55T is adversely affecting the operation of of the 5001 motherboard (incorrect installation of P2)	Unplug P2 and repeat power-up. If "5001" is displayed, this verifies that P2 was incorrectly installed. Turn the power off and repeat the P2 installation procedure as described in paragraph 2.4.6.
5001 displays all 8's followed by "Error 4"	Instrument calibration was disturbed during the installation of Option 55T	Perform instrument calibration as described in the Maintenance Section of the 5001 Instruction Manual.
5001 displays all 8's followed by "5001," but does not display "ton" or "AddrXX"	Obsolete firmware installed in the 5001 motherboard Note: this can only occur if the 5001 and Option 55T are purchased separately.	Refer to 5001 rear panel serial tag. If the serial number is between 1430-1439 or 1749-1788, verify that: U3 is 230542 Rev. J or later; U4 is 230541 Rev. J or later. For all other serial numbers, verify that: U3 is 230617 Rev. A or later; U4 is 230618 Rev. B or later.

3.1 INTRODUCTION.

3.1.1 This section presents operating information for the GPIB Option 55T. It assumes proper and safe installation on the Model 5001 Digital Multimeter (DMM). Refer to all figures and tables when referenced during the description to ensure a correct understanding of the operation of Option 55T.

3.2 OPERATION.

3.2.1 Before operating the 5001, it is strongly recommended that the operator read this entire section in order to avoid damage to the unit. Refer to paragraph 2.6.1 for any persistant Option 55T installation problems.

CAUTION

Do not proceed with operation of the 5001/55T system, unless any and all installation troubleshooting problems for the option have been remedied.

CAUTION

This instrument may be damaged if operated on line voltage other than that called for by the line voltage selection card P4.

3.3 GENERAL PURPOSE INTERFACE BUS (GPIB)

3.3.1 The IEEE-488-1978 (GPIB) Interface provides for limited remote programming and the output of data from the 5001. Inputs and outputs are made via a 24-pin connector (see Figure 3.1) located on the rear panel. The pin location, line identification and operation of Option 55T are in full compliance with IEEE-STD-488-1978. The

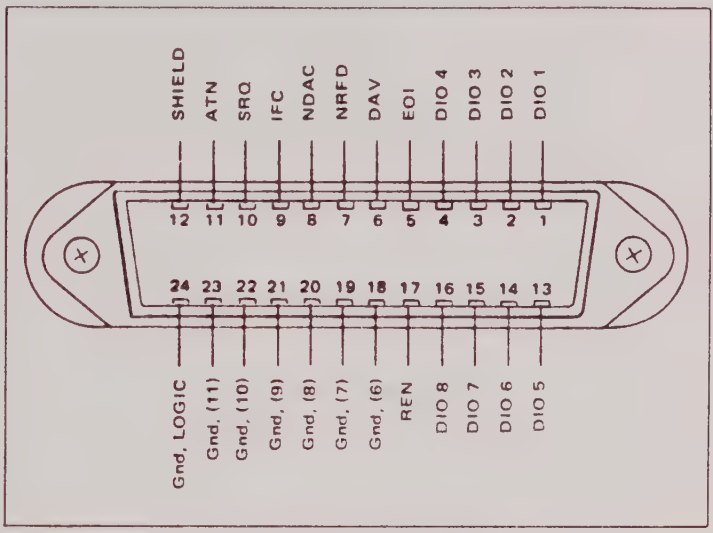


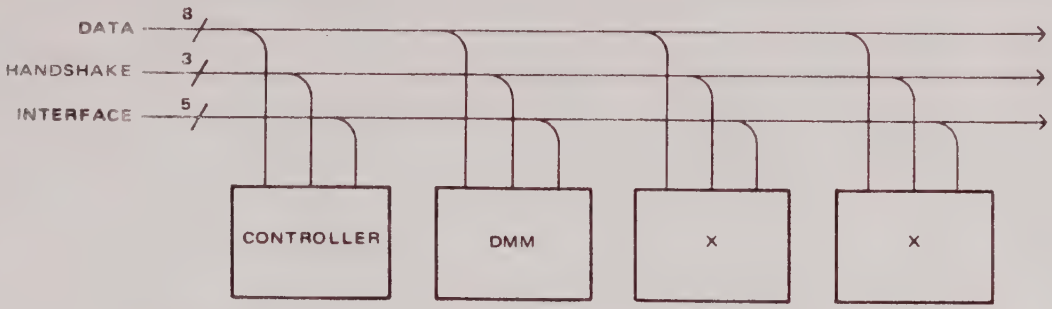
Figure 3.1 - IEEE-488 Connector (5001 Rear Panel)

option provides interface capability with other instruments and with controllers utilizing the "interface bus" structure. Connector pin assignments are shown in Figure 3.2. The IEEE-488-1978 subsets are listed in the Specifications (see Table 1.1.)

3.3.2 By assigning a unique address to the 5001, it can be "called up" by the controller without interfering with other instruments on the bus. Refer to paragraph 3.3.4 for instructions on programming the Option 55T Address/Talk Only function. Any one of 31 codes can be used for the address of the 5001, but a total of 15 is the maximum number of devices that can be connected to one bus system.

3.3.3 Option 55T Description.

3.3.3.1 Of the twenty-four lines available on the connector (shown in Figure 3.2) seven are grounds, one is a shield, and the remaining sixteen are signal lines. All of the signal lines are input,



PIN			PIN	
1	DIO-1 Data In/Out Bit 1 (LSB)	DATA LINES ARE USED TO TRANSFER DATA FROM ONE INSTRUMENT TO ANOTHER	12	SHIELD
2	DIO-2 Data In/Out Bit 2		18	GND/pin 6
3	DIO-3 Data In/Out Bit 3		19	GND/pin 7
4	DIO-4 Data In/Out Bit 4		20	GND/pin 8
13	DIO-5 Data In/Out Bit 5		21	GND/pin 9
14	DIO-6 Date In/Out Bit 6		22	GND/pin 10
15	DIO-7 Data In/Out Bit 7		23	GND/pin 11
16	DIO-8 Data In/Out Bit 8		24	LOGIC GND
6	DAV (DATA VALID)	HANDSHAKE LINES OPERATE IN A PROPER TIME SEQUENCE FOR COMPLETE COMMUNICATION BETWEEN INSTRUMENTS		
7	NRFD (NOT READY FOR DATA)			
8	NDAC (NOT DATA ACCEPTED)			
5	EOI (END OR IDENTIFY)	INTERFACE LINES ARE USED TO PROVIDE AN ORDERLY FLOW OF INFORMATION BETWEEN UNITS		
9	IFC (INTERFACE CLEAR)			
10	SRQ (SERVICE REQUEST)			
11	ATN (ATTENTION)			
17	REN (REMOTE ENABLE)			

Figure 3.2 - Interface Signal Pin Assignments

output, or bidirectional (input/output) lines and have the following characteristics:

Logic Levels: (1 = Low = $\leq$0.8V) (0 = Hi = $\geq$ 2.0V

Input Loading: Approximately two TTL loads for each input.

Output: The output is capable of driving 15 interface bus loads. It consists of an open collector driver and is capable of sinking 48 mA with a maximum voltage drop of 0.5 volts. (See IEEE-488 Electrical Specifications.)

3.3.3.2 The signal lines, as shown in Figure 3.2, consist of three functionally separate sets: Data, Handshake and Interface.

3.3.3.3 DATA.

3.3.3.3.1 The data lines consist of lines DIO-1 through DIO-8. These lines are the channels over which data flows between all instruments on the bus in bit parallel, byte serial form.

3.3.3.4 HANDSHAKE OPERATION.

3.3.3.4.1 See Figure 3.3 for a typical handshake flow chart. The transfer lines consist of: DAV (data valid), NDAC (not data accepted), and NRFD (not ready for data). These lines provide communication (between the instrument that is sourcing data and the instruments that are accepting data) to synchronize the flow of information across the eight DIO lines.

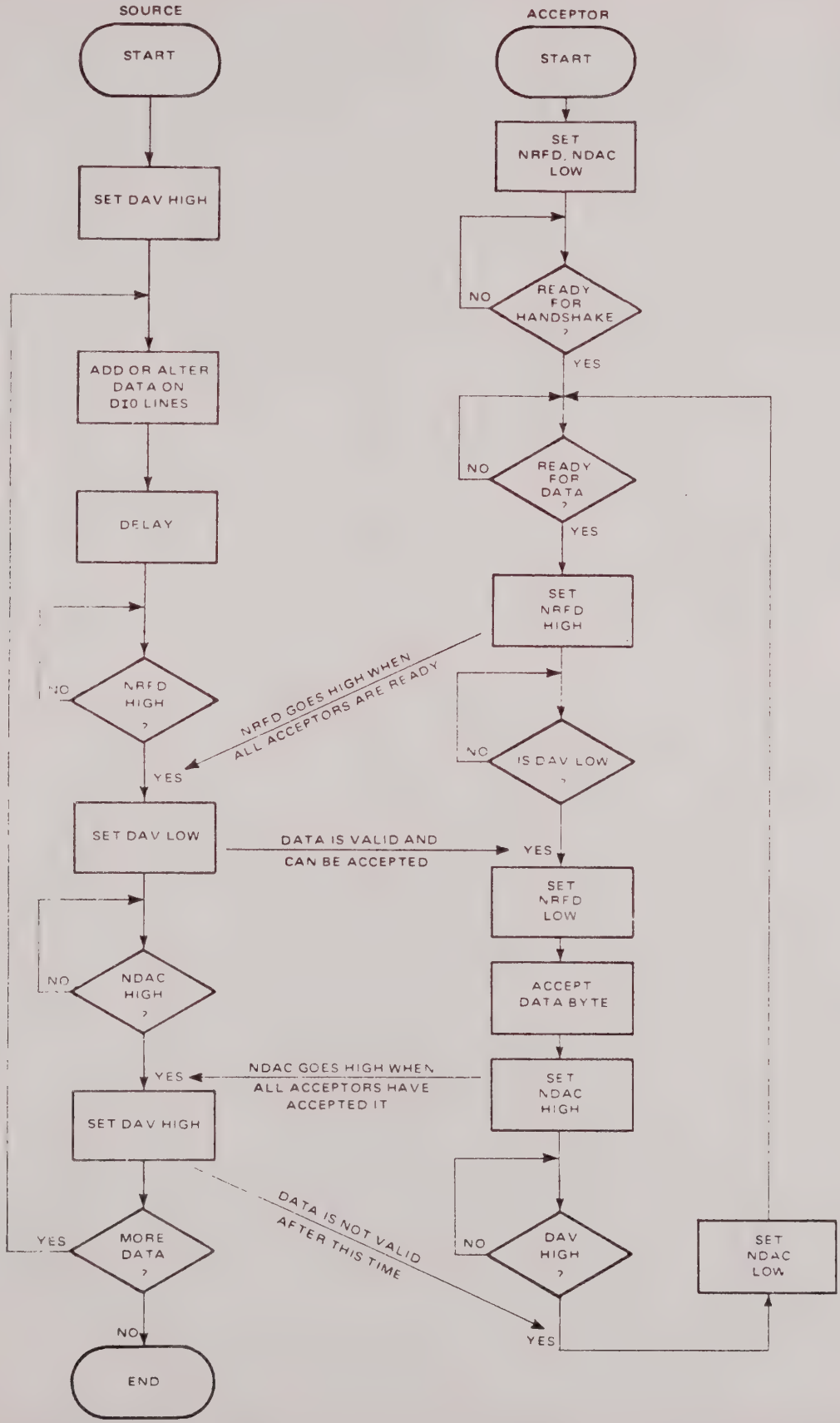


Figure 3.3 - Handshake Flow Chart

Table 3.1 - Instrument Address Selector

DECIMAL ADDRESS SETTING	ASCII CHARACTERS		DATA LINES						
			D_7	D_6	D_5	D_4	D_3	D_2	D_1
	TALK	LISTEN	TALK	LISTEN	ADDRESS				
					16	8	4	2	1
00		SP	0	1	0	0	0	0	0
	@		1	0	0	0	0	0	0
01		!	0	1	0	0	0	0	1
	A		1	0	0	0	0	0	1
02		"	0	1	0	0	0	1	0
	B		1	0	0	0	0	1	0
03		#	0	1	0	0	0	1	1
	C		1	0	0	0	0	1	1
04		$	0	1	0	0	1	0	0
	D		1	0	0	0	1	0	0
05		%	0	1	0	0	1	0	1
	E		1	0	0	0	1	0	1
06		&	0	1	0	0	1	1	0
	F		1	0	0	0	1	1	0
07		' APOSTROPHE	0	1	0	0	1	1	1
	G		1	0	0	0	1	1	1
08		(	0	1	0	1	0	0	0
	H		1	0	0	1	0	0	0
09		)	0	1	0	1	0	0	1
	I		1	0	0	1	0	0	1
10		*	0	1	0	1	0	1	0
	J		1	0	0	1	0	1	0
11		+	0	1	0	1	0	1	1
	K		1	0	0	1	0	1	1
12		,	0	1	0	1	1	0	0
	L		1	0	0	1	1	0	0
13		–	0	1	0	1	1	0	1
	M		1	0	0	1	1	0	1
14		.	0	1	0	1	1	1	0
	N		1	0	0	1	1	1	0
15		/	0	1	0	1	1	1	1
	O		1	0	0	1	1	1	1

DECIMAL ADDRESS SETTING	ASCII CHARACTERS		DATA LINES						
			D_7	D_6	D_5	D_4	D_3	D_2	D_1
	TALK	LISTEN	TALK	LISTEN	ADDRESS				
					16	8	4	2	1
16		Ø	0	1	1	0	0	0	0
	P		1	0	1	0	0	0	0
17		1	0	1	1	0	0	0	1
	Q		1	0	1	0	0	0	1
18		2	0	1	1	0	0	1	0
	R		1	0	1	0	0	1	0
19		3	0	1	1	0	0	1	1
	S		1	0	1	0	0	1	1
20		4	0	1	1	0	1	0	0
	T		1	0	1	0	1	0	0
21		5	0	1	1	0	1	0	1
	U		1	0	1	0	1	0	1
22		6	0	1	1	0	1	1	0
	V		1	0	1	0	1	1	0
23		7	0	1	1	0	1	1	1
	W		1	0	1	0	1	1	1
24		8	0	1	1	1	0	0	0
	X		1	0	1	1	0	0	0
25		9	0	1	1	1	0	0	1
	Y		1	0	1	1	0	0	1
26		:	0	1	1	1	0	1	0
	Z		1	0	1	1	0	1	0
27		;	0	1	1	1	0	1	1
	[		1	0	1	1	0	1	1
28		<	0	1	1	1	1	0	0
	\		1	0	1	1	1	0	0
29		=	0	1	1	1	1	0	1
	]		1	0	1	1	1	0	1
30		>	0	1	1	1	1	1	0
	^		1	0	1	1	1	1	0
31	NONE		ILLEGAL						

These lines derive their nomenclature from their meaning in the low or one state (e.g.: when NRFD is low, the device is Not Ready for Data).

a) DAV. Signifies that valid data is available on the DIO lines.

b) NRFD. Signifies that the instruments are not ready to accept information.

c) NDAC. Signifies that the information is not accepted by the acceptors.

3.3.3.5 INTERFACE LINES.

3.3.3.5.1 The five interface lines coordinate the flow of information on the bus.

a) Interface Clear

'IFC.' Places the 5001 interface in the IDLE state. (Untalk, Unlisten).

b) Attention

'ATN.' Indicates the nature of information on data lines during a handshake transfer sequence. Low indicates data lines carry interface commands; high indicates that the data lines carry device-dependent messages.

c) Remote Enable*

'REN.' Arms instrument to select Remote Operation (Low for Remote).

d) Service Request*

'SRQ.' Signals the controller that a peripheral or bus member wants attention for such purposes as transmitting measurement, status or condition information to the bus controller.

e) End or Identify*

'EOI.' Used for two purposes: (1) to signify the end of a message and (2) to signal bus peripherals to set the I/O bit assigned for parallel poll identification process.

*Option 55T does not implement those subsets of IEEE-488 which utilize these signal lines.

3.3.4 OPTION 55T ADDRESS ASSIGNMENT

3.3.4.1 When the 5001 is used as a system instrument, it must be assigned an address as a bus member. Assignment of the instrument address is performed by the user during the power-up sequence and uses one of the 31 decimal addresses available from 00 through 30.

3.3.4.2 Table 3.1 contains information for determining the talk and listen address codes used in programming the controller given the decimal address setting.

3.3.4.3 Refer to Table 3.1. Note that the left-hand panels show the decimal address setting. The right-hand panels show the data lines with their corresponding 7 bit binary code and appropriate ASCII character.

3.3.4.4 The 5001 reads the address from the non-volatile memory during the power-up sequence and transmits it to Option 55T. If the user wishes to temporarily change the address, the following procedure must be used:

a) Power-up the 5001 unit.

b) Enter the "address select mode" by pressing the STORE key while "AddrXX" or "ton" is displayed on the 5001's 7-segment display.

c) Press any front panel key other than STORE, 10K, or 1 K to toggle from addressed mode to "Talk Only" mode. The 7-segment LED's will display "AddrXX" or "ton" to indicate which mode is presently selected.

d) If the addressed mode is selected, press the 1K and 10K buttons to increment the most significant digit (MSD) and the least significant digit (LSD) of the displayed address.

e) Exit the "address select mode" by pressing the STORE key once again.

If the user wishes to permanently modify the address or "Talk Only" setting, hold the CAL switch depressed while performing step (e). This will store the new setting in the non-volatile memory.

3.3.4.5 Also, to eliminate a carriage return (CR) from the output string while operating in the "Talk Only" mode, select "Addr 30" followed by "ton" using the following procedure:

a) Power-up the 5001 unit.

b) Set the GPIB address to "30" using the procedure described in paragraph 3.3.4.4.

c) Toggle "Addr30" to "ton" by pressing any key except STORE, 1K or 10K.

d) Press the STORE key to send the "ton" message.

3.3.5 GPIB OPERATING SEQUENCE. EXAMPLE.

3.3.5.1 Table 3.2 and Figure 3.4 exemplify a GPIB operating sequence. The example assumes that the function switches on the 5001/55T are set to the DC volts function and the bus address is set to decimal "02." The example illustrates the transmission of program codes to the 5001/55T and the transmission of a DC measurement back to the controller.

3.3.5.2 Note that the left-hand column of Table 3.2 contains line numbers. These are used for reference purposes throughout the following description of the bus operation sequence. The column titled "Handshake Lines" indicates the high/low condition of the handshake lines at various points throughout the two-way transmission of information. In a similar fashion the columns titled "Interface Lines" and "Data Lines" contain entries reflecting the state of the interface lines and data lines during operation. The column titled "Meaning or Function" contains entries explaining the purpose of each operational step during the data transfer.

3.3.5.3 The timing chart is included to illustrate the condition of each individual bus line at each stage of the data transfer operation. Note that the timing chart includes numbers adjacent to each level change. These numbers refer to the individual line entries of the table.

3.3.5.4 The measurement operation used in Table 3.3 is a simple voltage measurement. The GPIB program codes are as follows: Function Output Enabled and Trigger Continuous. The significance of these program codes is shown in the meaning or function column of the table in lines 17 through 22 and the program string required to perform this measurement is F1T1CRLF. The program string includes a carriage return (CR) and line feed (LF).

3.3.5.5 For purposes of this example, it is assumed that the 5001 has been assigned a decimal address of "02" and that the controller has a talk address of "U." It is further assumed that both the controller and 5001 are system-connected, turned on and operational.

3.3.5.6 Lines 1 through 13 in Table 3.2 show the detailed operation of the bus for one handshake cycle (i.e.: the transmission of one ASCII character as a bus message). Lines 14 through 42 do not indicate the detail of each handshake cycle; rather, they indicate only the transmission of the characters required for the programming commands and the subsequent transmission of the data by the 5001/55T. Each transmission by the controller or 5001/55T, as shown in lines 14 through 42, requires the handshake cycle illustrated by line entries 1 through 13 of the table.

3.3.5.7 Line 1 of Table 3.2 indicates that the first operation performed is the setting of the Remote Enable (REN)* line to the low state. As explained in the table, this operation arms the bus members to go to the remote mode. The controller then transmits the interface clear (IFC) signal which stops bus activity and the attention

Table 3.2 - Bus Operation Sequence

	HANDSHAKE LINES	INTERFACE LINES	DATA LINES	MEANING OR FUNCTION
1		REN Lo		Arms bus peripherals to go to remote mode.
2		IFC		Stops activity on the bus.
3		ATN Lo		Signifies that data byte will be a "Bus Message."
4	NRFD Hi			5001/55T says ready for data.
5			?	UNL (unlisten) message (ASCII character ?) on data bus by controller means "all bus peripherals unlisten".
6	DAV Lo			Controller says data on bus is valid.
7	NRFD Lo			5001/55T says its not ready for new data; do not change data lines while 55T is accepting data.
8				5001/55T reads data lines.
9	NDAC Hi			5001/55T says it has read data.
10	DAV Hi		?	Controller says data no longer valid.
11	NDAC Lo			5001/55T removes data accepted flag.
12	NRFD Hi			5001/55T says it's ready for next data byte.
13				Controller removes or changes data on bus.
14			U	"I talk," controller becomes talker (Controller talker address).
15			"	"You listen," addressed peripheral becomes listener (in this case it is the 5001/55T set to decimal address 02; see table 3.1.)
16		ATN Hi		Signifies that data byte will be a "Device Dependent Message" as opposed to an "Interface Message".
17			F	Format
18			1	Print Function Code
19			T	Trigger
20			1	Continuous
21			CR	End of transmission by Controller.
22			LF	
23		ATN Lo		Byte to follow is a Bus Message.
24			?	UNL (unlisten) bus message.
25			B	"You talk," 5001/55T talk address (02).
26			5	"I listen," Controller listen address.
27		ATN Hi		Message to be transmitted is Data.
28			V	Function Code
29			D	
30			C	
31			SPACE	
32			SPACE	
33			SPACE	Positive Sign.

Table 3.2 - Bus Operation Sequence *(Continued)*

	HANDSHAKE LINES	INTERFACE LINES	DATA LINES	MEANING OR FUNCTION
34			1	Measurement Data
35			•	
36			0	
37			4	
38			5	
39			6	
40			7	
41			CR	End of Message
42			LF	

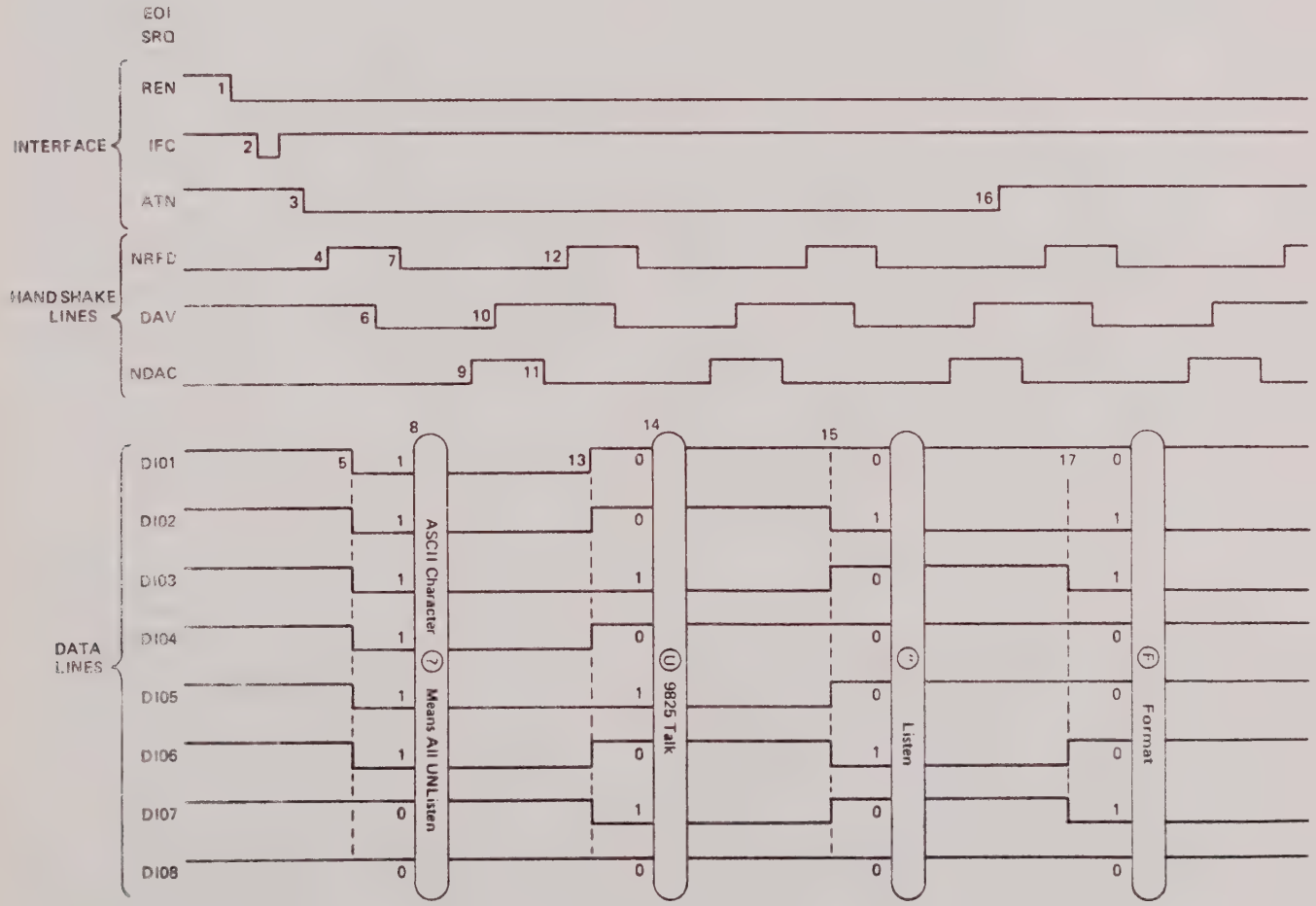


Figure 3.4 - Handshake Timing

(ATN) line is set low indicating that the next data placed on the bus by the controller will be an interface message. Note in the timing chart that when the ATN line is set low (3) that the 5001/55T responds by setting the NRFD line high (4). This response by the 5001/55T indicates that it is now ready to accept data.

3.3.5.8 When the 5001/55T transmits the ready for data signal by setting the NRFD line high (4), the controller puts the interface message UNL on the data lines. As indicated in (5) this is the ASCII character "?". This unlisten message is a universal message understood by all bus members as the commands "Unlisten." Having placed the data character on the lines, the controller now says the data is valid by setting the DAV line low (6). The 5001/55T then says "I'm going to accept the data now on the data lines; don't change the data lines." The 5001/55T then reads the data lines (8) and acknowledges acceptance of the data by setting the NDAC line high (9). The controller then says the data is no longer valid by setting the DAV line high (10). Then, the 5001/55T removes the data accepted flag by setting the NDAC line low (11) and says it is ready for the next data byte by setting the NRFD line high (12). The controller, since asserting that the data is no longer valid (10), is either removing or changing data on the bus.

*Option 55T does not implement the Remote/Local subsets of IEEE-488 which utilizes this signal line.

3.3.5.9 At this point, one ASCII character has been transmitted by the controller to the 5001/55T and the 5001/55T is now ready to accept a new data byte (this was indicated when the 5001/55T set the NRFD line high). Now the controller puts the next character on the data line and the handshake cycle for the transfer of the character is repeated. The next character transmitted by the controller is the ASCII character "U" which is the talk address of the controller. As indicated in Table 3.2, by transmitting this character the controller is making itself a talker. The next character transmitted is the quotation mark which is the listen address of the 5001/55T when it has been assigned the decimal address "02."

3.3.5.10 Lines 17 through 22 of the table illustrate the sequence of transmission of the program string to the 5001/55T to output the function code with each reading and to go to a continuous trigger mode of operation. Lines 21 and 22 of the table indicate the end of transmission with the characters CR (Carriage Return) and LF (Line Feed). (Note that at line 16 of the table the controller had set the ATN line high indicating that the program string to follow in lines 17 through 22 would be a device-dependent message.)

3.3.5.11 Having transmitted the program string of device messages to the 5001, the controller then sets the ATN line low (23) which indicates that the characters to follow in lines 24 through 26 are interface messages. These interface messages change the talker/listener relationship of the controller and 5001/55T; the 5001/55T is made a talker and the controller becomes a listener.

3.3.5.12 Lines 28 through 42 show the sequence of the transmission of data by the 5001/55T. The handshake sequence is the same when the 5001/55T is transmitting data as that outlined in lines 1 through 13 of the table, except the 5001/55T is now controlling the handshake line DAV.

3.3.5.13 Upon completion of the data transmission, the 5001/55T transmits a carriage return (CR) and line feed (LF) to indicate the end of the data transmission. (Refer to the Specifications - Table 1.1 - for the programming requirements for the Option 55T.)

3.3.6 Interface Message Repertoire.

3.3.6.1 The 5001/55T is equipped with a standard GPIB interface which conforms to the specifications contained in IEEE-488-1978. This specification includes the definition of multi-line interface messages and divides the messages into two groups; the primary command group and the secondary command group. The 5001/55T includes none of the secondary command group in its interface message repertoire.

3.3.6.2 The primary command group of interface messages is further broken down into four

lower categories: (1) the listen address group, (2) the talk address group, (3) the universal command group and (4) the addressed command group. The 5001/55T is designed to include in its interface message repertoire 31 listen addresses and 31 talk addresses. The listen and talk addresses to which the 5001/55T may be set are listed in Table 3.1.

3.3.6.3 The interface messages to which the 5001 is designed to respond are listed in Table 3.3 along with their decimal equivalents, hex equivalents, meanings and data line codes. The function of the 5001 in response to each of these commands is described in the following paragraphs.

3.3.6.4 SELECTED DEVICE CLEAR (SDC)

3.3.6.4.1 Upon receipt of the SDC command, the 5001 will go to the home state. The decimal and hex equivalents are both 04. The SDC message has the same effect as transmitting the GPIB program code T1 to the 5001.

3.3.6.5 GROUP EXECUTE TRIGGER (GET).

3.3.6.5.1 As shown in Table 3.3, the decimal and hex equivalents of the GET command are both 08. Upon receipt of the GET interface message, the 5001/55T will trigger a reading if it had previously been placed in the HOLD mode. The GET command is used to trigger the simultaneous execution of multiple functions by a number of bus members. To use this command, one or more bus members are programmed to perform a function on receiving the GET interface message. Subsequently, the controller will transmit the GET command and all bus members previously programmed will begin execution on receipt of the command.

3.3.6.6 DEVICE CLEAR (DCL).

3.3.6.6.1 The decimal equivalent of the DCL command (as shown in Table 3.3) is 20, and the hex equivalent is 14. This command is identical in operation to the SDC command, except that the 5001/55T need not be a listener in order to respond to the DCL. When this command is transmitted on the bus, all devices on the bus which respond to the DCL will clear. The DCL message has the same effect on the 5001 as transmitting the GPIB program code T1.

3.3.6.7 UNLISTEN (UNL).

3.3.6.7.1 As shown in Table 3.3 the decimal equivalent of this command is 63; the hex equivalent is 3F. This command is also a universal interface message understood by all members of the bus as a command to go to the unlisten state. When this command is transmitted, all bus members previously in the listen state will return to the unlisten state.

3.3.6.8 UNTALK (UNT)

3.3.6.8.1 As shown in Table 3.3, the decimal equivalent of this command is 95; the hex equivalent is is 5F. This command is also a universal interface message understood by all members of the bus as a

Table 3.3 - Interface Messages Used With The 5001

Message	Meaning	HEX CODE	Decimal Equiv.	DATA LINE CODE						
				7	6	5	4	3	2	1
SDC *	Selected Device Clear	04	4	0	0	0	0	1	0	0
GET *	Group Execute Trigger	08	8	0	0	0	1	0	0	0
DCL	Device Clear	14	20	0	0	1	0	1	0	0
UNL	Unlisten	3F	63	0	1	1	1	1	1	1
UNT	Untalk	5F	95	1	0	1	1	1	1	1

*Instrument will ignore message unless it is a listener

command to go to the untalk state. When this command is transmitted, any bus member previously in the talk state will return to the untalk state.

3.3.7 Device-Dependent Messages

3.3.7.1 The messages which control the operation of the 5001/55T when in system operation are referred to as device-dependent messages. The device-dependent program codes for the 55T are limited to the Trigger Command Message and Output Format Command sets. Messages in these arrays are simply combinations of ASCII characters which the instrument recognizes as specific instructions. To program the 5001/55T for a specific operation, the operator programs the controller to transmit a sequence of these messages (program string). The program string is variable in length and has no fixed format. Individual commands may be transmitted in any order and require no delimiters or spacing for the 5001/55T to understand. At least one terminator character must be sent as the last character in each program string. Acceptable terminators include CR (Carriage Return), LF (Line Feed), or ASCII X upper or x lower case. Most controllers will add the terminator to the program automatically. (Refer back, if necessary, to Table 1.1 which summarizes the Option 55T programming requirements.) To assemble a program string, first list the requirements of the program and then select the appropriate program codes. (Refer back, if necessary, to Table 3.2 which shows a program string listing for a typical measurement procedure.)

3.3.7.2 TRIGGER COMMANDS.

3.3.7.2.1 These commands are listed in Table 3.4 along with special notes. The commands are numbered T0 - T5 and they enable the 5001 to be used in either the internal or the bus-triggered mode. The trigger commands program the availability of readings sent from the 5001 to Option 55T for output on the bus. To assemble a program string, first list the requirements of the program and then select the appropriate program codes from this table. Also, refer back, if necessary, to Table 3.2 which shows a program string listing for a typical measurement procedure.

> **NOTE**
>
> The 5001 will continue to trigger internally and display readings even when programmed to the HOLD mode over the bus. Also, bus outputs will cease if the 5001 is placed in the STORE or RECALL mode from the keyboard, or if an error message is on the 5001 display.

3.3.7.2.2 When programmed with the T1 command, the 5001/55T is in the continuous reading mode making **all** readings available for output to the bus. The continuous reading mode is the normal power-up trigger condition for the 5001/55T. When operating in this mode, the 5001/55T is very similar to most other Racal-Dana systems-DMM's operating in the continuous reading mode.

3.3.7.2.3 In measurement systems where multiple signals are being switched to the 5001's input under the supervision of a GPIB controller, the HOLD mode enables the 5001/55T to disregard readings transmitted across guard which, in turn, prevents the outputting of such readings on the bus.

Table 3.4 - Option 55T Trigger Commands

OPERATION	PROGRAM CODE	SPECIAL NOTES
Trigger Immediate	T0	Used in conjunction with T2–T5
Internal Trigger	T1	Readings Continuously Made Available for Bus Output
Hold	T2	Hold Mode with No Delay
Hold	T3	Hold Mode with 4 Rdg. Delay
Hold	T4	Hold Mode with 6 Rdg. Delay
Hold	T5	Hold Mode with 8 Rdg. Delay

There are four HOLD mode trigger commands, T2–T5. These HOLD modes provide a dual programming function. First, they program the 5001/55T for the HOLD mode. Additionally, Hold-with-delay commands T3 through T5 (see Paragraph 3.3.7.2.6 and Table 3.5) provide for an N reading delay to allow for full settling of the 5001's analog and digital filters, thus improving the accuracy of the first reading output to the bus. (The T2 trigger command provides for a HOLD mode with no delay.)

3.3.7.2.4 Once the 5001/55T has been programmed to the HOLD mode, it can be triggered in one of two ways:

1) By programming the 5001/55T with a "T0" command.

2) By making the 5001 a listener and sending the interface command "GET" (Group Execute Trigger).

3.3.7.2.5 Once the 5001/55T has been triggered, it delays internally by "throwing away" the next N–1 readings which the GPIB interface receives from the 5001 (where N is equal to 4, 6 and 8 for the T3, T4 and T5 Hold-with-delay commands.) When the Nth reading is transmitted, it is made available for output to the bus. (The 5001/55T then reenters the HOLD mode and awaits another trigger command.) For example, the command sequence T5, T0 would make the 8th reading transmitted to the 55T, immediately after reception of the T0 command, available for output.

3.3.7.2.6 In all instances, the T5 command can be used to program the 5001/55T for the HOLD mode. The 8 reading delay programmed by the T5 command compensates for the worst case 5001 filter settling times and, therefore, always provides for full accuracy of the 1st reading output to the bus. For applications which require increased throughput, Hold-with-delay commands with shorter readings delays, T2–T4, are provided to allow the system programmer the capability of optimizing single trigger response time from the 5001/55T. The optimum Hold-with-delay command to be used depends upon the function and range presently selected, the filter position, and the maximum expected input digit change prior to single triggering the 5001/55T.

Table 3.5 - Hold-with-Delay Commands Required to Compensate for 5001 Settling Times

FUNCTION	RANGE	FILTER	MAXIMUM DIGIT CHANGE WITHIN:			
			≤5	≤24	≤100	≤1500†
DC,Kohms	.1	IN	T5	T5	T5	T2
Kohms	1K,10K*	IN	T4	T4	T4	T2
Kohms	10K**	IN	T5	T5	T5	T5
Other	Other	IN	T3	T3	T3	T2
DC,Kohms	.1	OUT	T5	T5	T2	T2
Kohms	1K,10K*	OUT	T4	T4	T2	T2
Kohms	10K**	OUT	T5	T5	T5	T2
Other	Other	OUT	T3	T2	T2	T2

† For digit changes greater than 1500 digits use T2.
* Input < 23 meg Ω
** Input ≥ 23 meg Ω

3.3.7.2.7 The maximum expected input digit change is the maximum expected change in the input signal applied to the 5001 immediately preceding the transmission of a T0 single trigger command to the 5001/55T. For example, refer to Figure 3.5 which graphically represents the magnitude of the input signal applied to the 5001 input terminals. At time t_A the input is 1.00000 VDC and remains the same until time t_B when the input is changed and is expected to be within the range of the shaded area. As shown, the maximum expected change in the input signal is .00050 VDC or 50 digits from the 1.00000 VDC input prior to time t_B. At time t_C the 5001/55T has received the T0 single trigger command. Therefore, the maximum expected input digit change prior to single triggering of the 5001/55T is 50 digits.

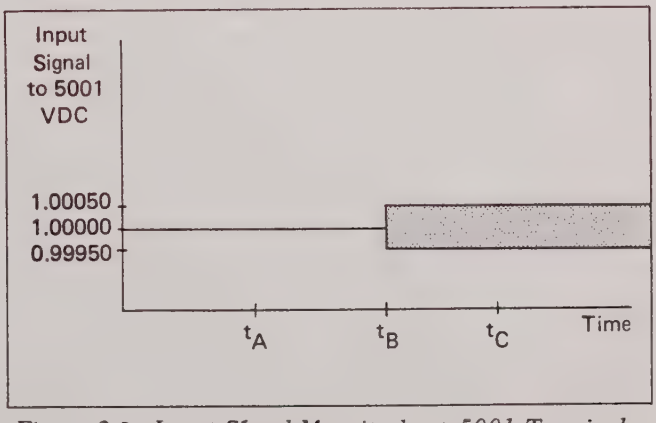


Figure 3.5 - Input Signal Magnitude at 5001 Terminals

3.3.7.2.8 Table 3.5 presents the recommended Hold-with-delay commands to use for minimum 5001/55T single trigger response time. For example, with an input of .100000 VDC on the .1 range; the filter out; and the maximum change of the input signal expected to be less than 100 display digits (< .0001000 VDC) but greater than 24 display digits, one looks in Table 3.5 for the correct Hold-with-delay command. On the .1 range filter out now under the ≤ 100 digit change column, one finds the T2 command.

Table 3.6 - Option 55T Format Commands

OPERATION	PROGRAM CODE	SPECIAL NOTES
Disable Function Output	F0	Output: 5-spaces preceding each reading
Enable Function Output	F1	Output: 5-character function code preceding each reading.

3.3.7.3 FORMAT COMMANDS.

3.3.7.3.1 Table 3.6 shows the format commands, F0 and F1. Program code F0 causes the function code output to be replaced with 5 spaces. The use of the F0 command prevents any problems which might arise due to controllers which are sensitive to alpha characters imbedded in the numerical data strings. The F1 command programs the 5001/55T to output the function code preceding the reading. This is the normal power-up mode of Option 55T. The data output format in Table 1.1 shows all the available function codes. The "%" function code is output when the % function is selected. The "rdgs" function code is output when the reading N is selected as the output parameter from the Low, Average, and High (LAH) function.

Table 3.7 - Optional Command String Terminator

OPERATION	CODE	SPECIAL NOTES
Terminator	X	Use as required only when the 5001/55T is being programmed from a controller which does not terminate the program string with a CR or LF

3.3.7.4 TERMINATOR

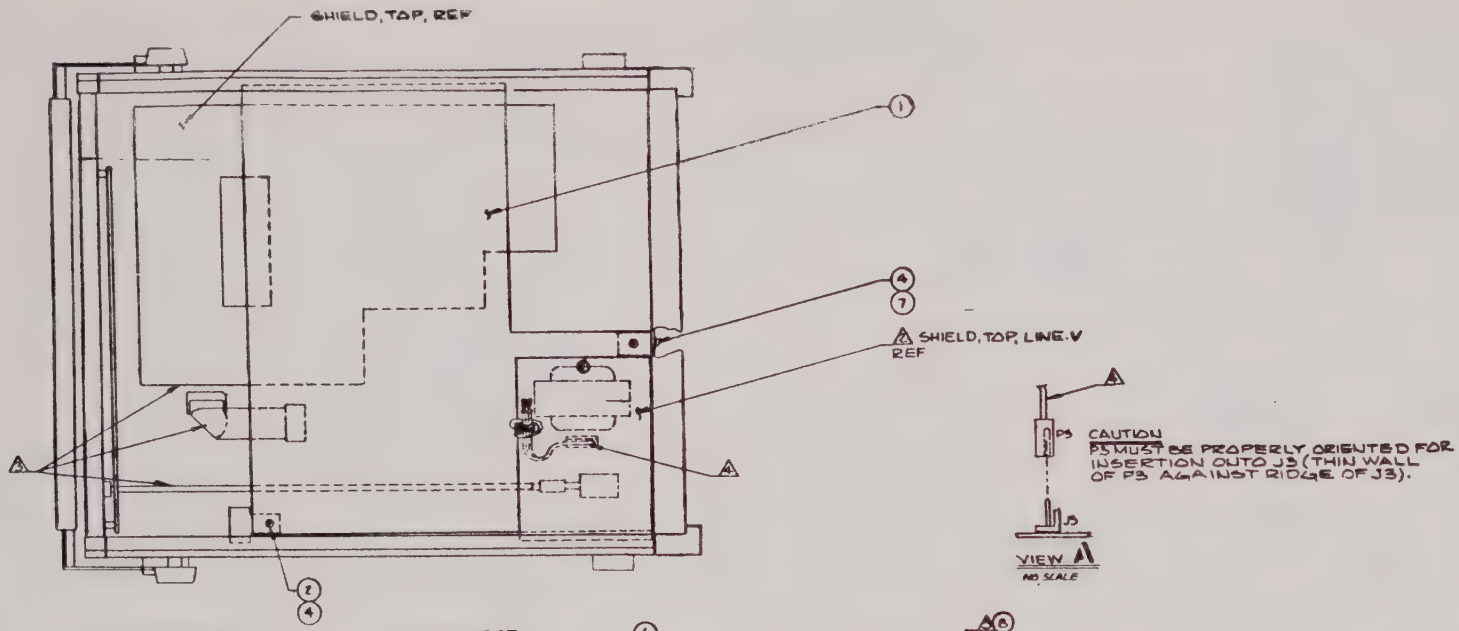
3.3.7.4.1 Table 3.7 shows the optional command string terminator "X" with a special note indicating when it is mandatory for use.

NOTE

Option 55T will terminate on any unrecognized character. Program code "X" is preferred in order to maintain compatability with other Racal-Dana products.

SECTION 6 DRAWINGS

GPIB Assembly (404024) 6-2
PCB Assy., GPIB(401681) 6-3
Schematic, GPIB (431681) 6-4



6. ITEM 9 TO BE SHIPPED WITH INSTRUMENT.

⚠ REMOVE BUTCH PLATE (454527) REF. & ITS MOUNTING HARDWARE FROM REAR PANEL TO ALLOW INSERTION & MOUNTING OF GPIB CONNECTOR. ALSO DISCARD NUTS & LOCKWASHERS FROM HARDWARE KIT.

⚠ CABLE P3 MUST BE ROUTED TO AVOID INTERFERENCE WITH THE 5001 AC POWER PUSH ROD AND THE 5001 MOTHERBOARD TRANSFORMER, T1.

⚠ CABLE P2 MUST BE ROUTED TO MAINTAIN 1/2" MINIMUM SPACING AWAY FROM 5001 TOP SHIELD AND 5001 AC POWER PUSH ROD

⚠ SHIELD TOP LINE V MUST BE REINSTALLED AS SHOWN WHEN INSTALLING ITEM 1.

1. ASSEMBLY PROCESSES & PROCEDURES TO CONFORM TO RACAL-DANA WORKMANSHIP STANDARD.

NOTES UNLESS OTHERWISE SPECIFIED

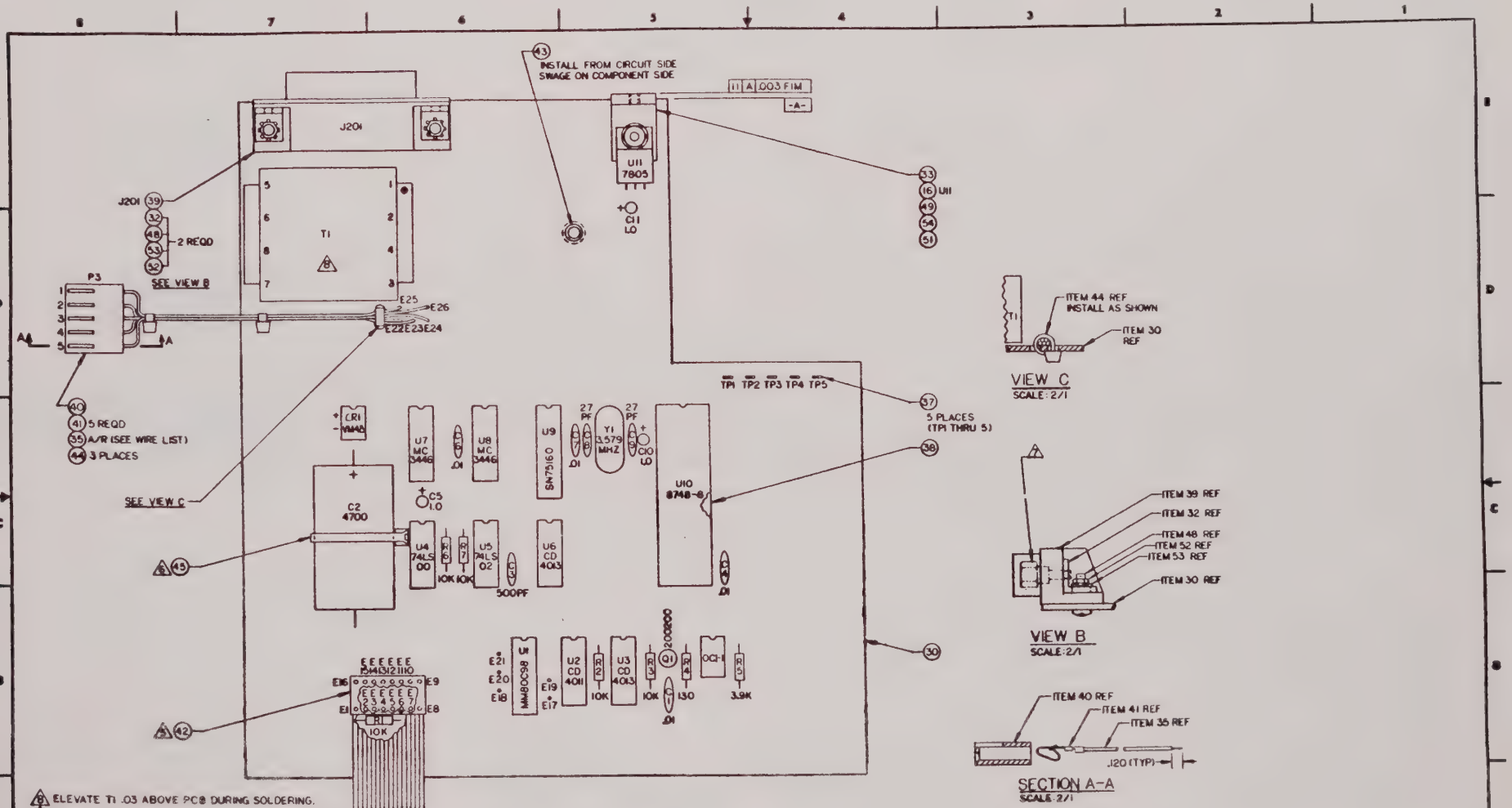
PROPRIETARY NOTICE

THIS DOCUMENT AND THE TECHNICAL DATA HERE ON DISCLOSED ARE PROPRIETARY TO RACAL DANA INSTRUMENTS INC AND SHALL NOT WITHOUT EX PRESS WRITTEN PERMISSION OF RACAL DANA IN STRUMENTS INC BE USED RELEASED OR DISCLOSED IN WHOLE OR IN PART OR USED TO SOLICIT QUOTA TIONS FROM A COMPETITIVE SOURCE OR USED FOR MANUFACTURE BY ANYONE OTHER THAN RACAL DANA INSTRUMENTS INC THE INFORMATION HERE ON HAS BEEN DEVELOPED AT PRIVATE EXPENSE AND MAY ONLY BE USED FOR PURPOSES OF ENGI NEERING EVALUATION AND FOR INCORPORATION INTO TECHNICAL SPECIFICATIONS AND OTHER DOC UMENTS WHICH SPECIFY PROCUREMENT OF PRO DUCTS FROM RACAL DANA INSTRUMENTS INC

GPIB ASSY, 55T

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	404204	A

SCALE NONE SHEET 1 OF 2



(B) ELEVATE T1 .03 ABOVE PCB DURING SOLDERING.

(A) ALIGN AND HOLD ITEM 32 TO HOLES IN CONNECTOR DURING INSTALLATION OF ITEMS 48,52 AND 53. ALIGNMENT MAY BE MADE USING STUDS FROM A 6-30011 HARDWARE KIT

(B) POSITION LOCKING PORTION OF ITEM 45 ON C2 APPROX AS SHOWN.

(A) "DESIGNATIONS E1 THRU E16 APPEAR ON PC BOARD ONLY," APPEAR ON PC BOARD ONLY.

4. CAPACITORS ARE IN UF
3. RESISTORS ARE IN OHMS
2. REFERENCE SCHEMATIC NUMBER 451681
1. ASSEMBLY PROCESSES AND PROCEDURES TO CONFORM TO RACAL-DANA WORKMANSHIP STANDARD

NOTES: UNLESS OTHERWISE SPECIFIED

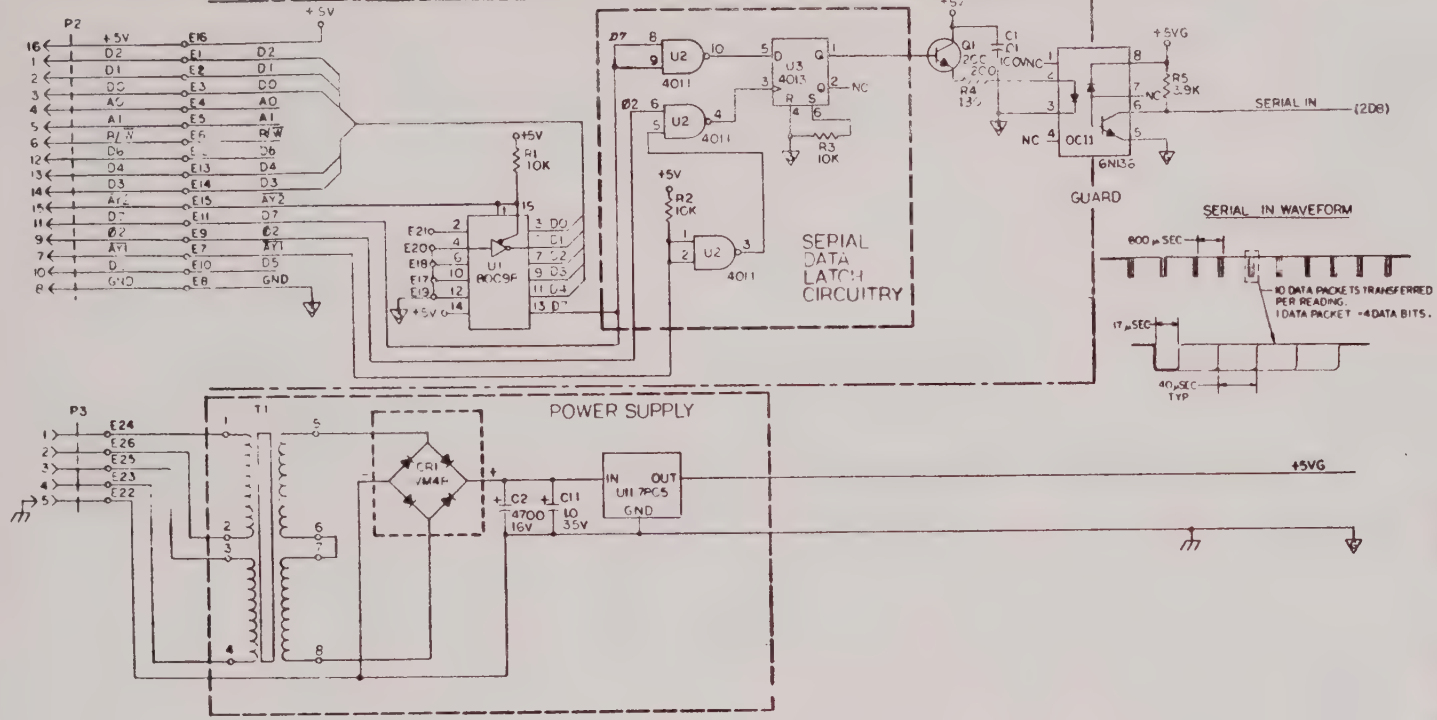
PROPRIETARY NOTICE

THIS DOCUMENT AND THE TECHNICAL DATA HERE ON DISCLOSED ARE PROPRIETARY TO RACAL-DANA INSTRUMENTS INC. AND SHALL NOT BE ... PRIOR WRITTEN PERMISSION OF RACAL-DANA INSTRUMENTS INC. IT MAY NOT BE USED, RELEASED OR DISCLOSED IN WHOLE OR IN PART OR USED TO SOLICIT ... FROM A COMPETITIVE SOURCE OR FOR MANUFACTURE BY ANYONE OTHER THAN RACAL-DANA INSTRUMENTS INC. THE INFORMATION HERE ON HAS BEEN DEVELOPED AT PRIVATE EXPENSE AND MAY ONLY BE USED FOR PURPOSES OF ENGINEERING EVALUATION AND FOR INCORPORATION INTO TECHNICAL SPECIFICATIONS AND OTHER DOCUMENTS WHICH SPECIFY PROCUREMENT OF PRODUCTS FROM RACAL-DANA INSTRUMENTS INC.

PCB ASSEMBLY, GPIB

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	401681	A

SCALE 2/1 SHEET OF 5



UNUSED LOGIC NETWORK			CONNECTED	NC
DES	TYPE	PINS IN	TO	PINS OUT
U2	4011	12,13	+5VG	11
U3	4013	8-11	GND	12,13
U4	74LS00	4-6,12,13	+5VG	8,11
U10	8748	5,25		8,9,10,39

REF DES	IC TYPE	PIN NO. +5V	PIN NO. GND
U3	4013	14	7
U2	4011	14	7
U1	80C98	16	8
INGUARD IC POWER CONNECTIONS			

REF DES	IC TYPE	PIN NO. +5VG	PIN NO. GND
U10	8748	40	20
U9	75150	20	10
U7,8	MC3447	16	8
U5	74LS02	14	7
U4	74LS00	14	7
U6	4013	14	7
OUTGUARD IC POWER CONNECTIONS			

HIGHEST REFERENCE DESIGNATIONS	NOT USED
U1	
J201	
P3	
TP5	
Q1	
U11	
T1	
D7	
OC11	
C11	

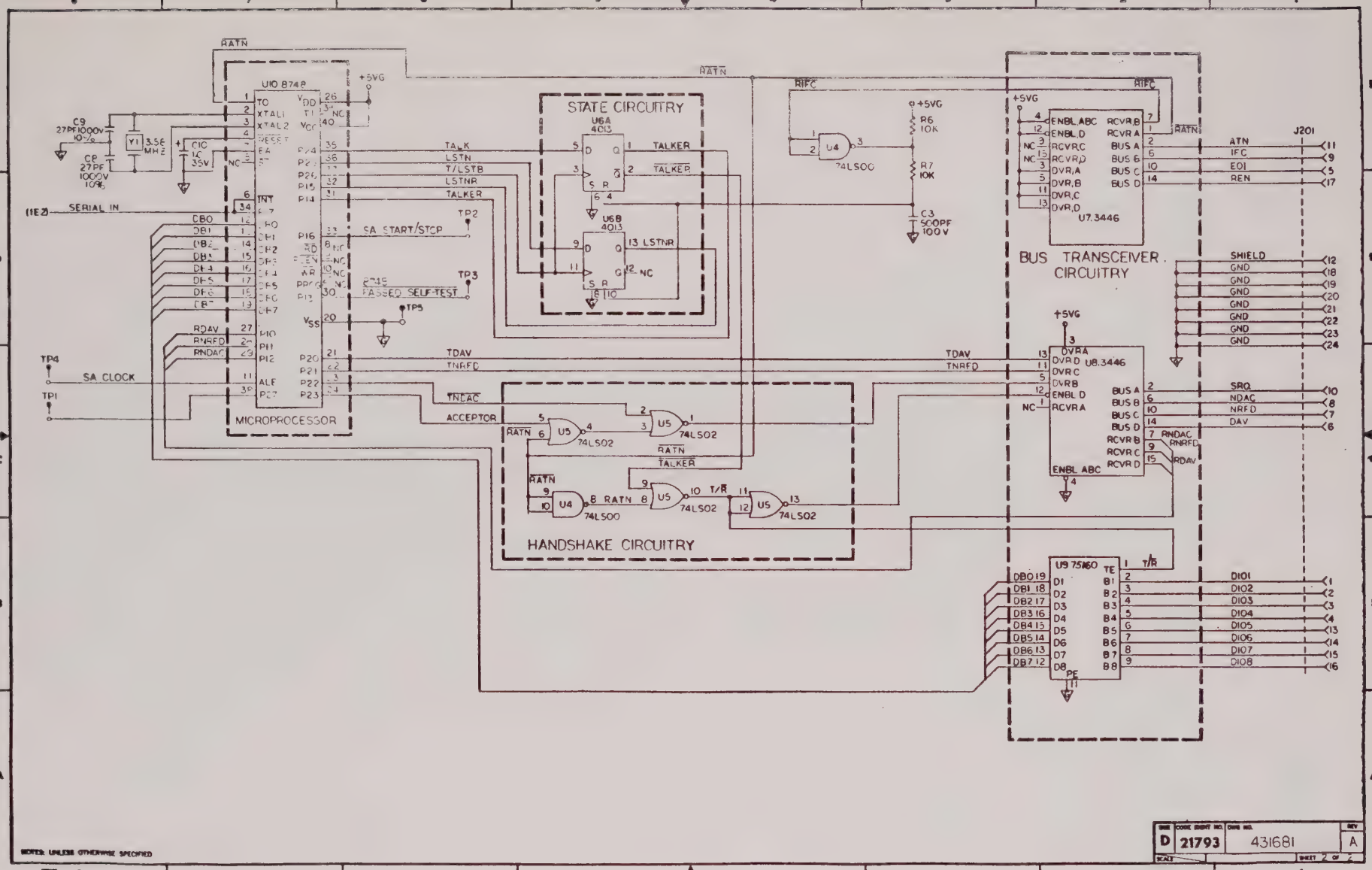
PROPRIETARY NOTICE

THIS DOCUMENT AND THE TECHNICAL DATA HERE ON DISCLOSED ARE PROPRIETARY TO RACAL DANA INSTRUMENTS INC. AND SHALL NOT WITHOUT EXPRESS WRITTEN PERMISSION OF RACAL DANA INSTRUMENTS INC BE USED RELEASED OR DISCLOSED IN WHOLE OR IN PART OR USED TO SOLICIT QUOTATIONS FROM A COMPETITIVE SOURCE OR USED FOR MANUFACTURE BY ANYONE OTHER THAN RACAL DANA INSTRUMENTS INC THE INFORMATION HERE ON HAS BEEN DEVELOPED AT PRIVATE EXPENSE AND MAY ONLY BE USED FOR PURPOSES OF EVALUATION AND FOR INCORPORATION INTO TECHNICAL SPECIFICATIONS AND OTHER DOCUMENTS WHICH UNLESS PROCURED FROM RACAL DANA INSTRUMENTS INC

2. CAPACITOR VALUES ARE IN MICROFARADS. ±20%.
1. RESISTOR VALUES IN OHMS. ±5% 1/4 WATT.

NOTES: UNLESS OTHERWISE SPECIFIED

SCHEM GPIB			
SIZE D	CODE IDENT NO. 21793	DWG NO. 431681	REV A
SCALE		SHEET 1 OF 2	



NOTES: UNLESS OTHERWISE SPECIFIED

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	431681	A
SCALE		SHEET 2 OF 2	

SECTION 7 PARTS LIST

7.1 This section contains lists of replaceable parts arranged in the order of the following subassemblies:

GPIB Assy (404204) 7-2
PCB Assy, GPIB (401681) 7-3

7.2 Manufacturers are identified by FSC numbers listed in Table 7.1, "List of Suppliers". The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1, H4-2 and their supplements.

Table 7.1 - List of Suppliers

FSC	NAME
00779	AMP, INC. HARRISBURG, PENNSYLVANIA
01295	TEXAS INSTRUMENTS, INC. DALLAS, TEXAS
02735	RCA SOLID STATE DIV. SOMERVILLE, NEW JERSEY
04713	MOTOROLA, INC. (SEMI-CONDUCTOR PRODUCTS DIV.) PHOENIX, ARIZONA
05397	UNION CARBIDE CORP. (MATERIALS SYSTEMS DIV.) CLEVELAND, OHIO
21793	RACAL-DANA INSTRUMENTS INC. IRVINE, CALIFORNIA
25159	INDUCTIVE COMPONENTS, INC HAUPPAUGE, NEW YORK
27014	NATIONAL SEMI-CONDUCTOR CORP. SANTA CLARA, CALIFORNIA
27264	MOLEX PRODUCTS CO. DOWNERS GROVE, ILLINOIS
27777	VARO ELECTRAN DEVICES, INC. GARLAND, TEXAS
50434	HEWLETT-PACKARD CO. (HPA DIV.) PALO ALTO, CALIFORNIA
56289	SPRAGUE ELECTRIC CO. N. ADAMS, MASSACHUSETTS
81349	MILITARY SPECIFICATION

404204 - GPIB Assy, 55T

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
1	401681	PCB ASSEMBLY, GPIB	21793	401681
2	454589	PLATE, MOUNTING, GPIB	21793	454589
4	615043	SCREW, PHILLIPS PAN HD 4-40 X .312		
6	615060	SCREW, PHILLIPS PAN HD 6-32 X .437		
7	617127	WASHER, SPLIT LOCK #4		
8	630011	KIT, HARDWARE	21793	630011
9	980568	INSTR-MNL. 5001 OPT 55T	21793	980568

401681 - Assy., PCB GPIB

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
C1	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C2	110185	CAP ELECT 4700 MFD 16 V		16TAL4700
C3	100016	CAP CERAM 500 PFD 100 V 20%	56289	C023B102E501M
C4	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C5	110143	CAP TANTA 1 MFD 35 V 20%	05397	T368A105M035AS
C6	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C7	100017	CAP CERAM .01 MFD 100 V 20%	56289	C023B101F103M
C10	110143	CAP TANTA 1 MFD 35 V 20%	05397	T368A105M035AS
C11	110143	CAP TANTA 1 MFD 35 V 20%	05397	T368A105M035AS
CR1	230465	IC DIODE BRIDGE VM48	27777	VM48
J201	601024	CON, PCB, 24 PIN GPIB	00779	55271-2
OCI-1	250006	HI SPEED OPTICAL ISOLATOR	50434	HP5082-4351
P3	601093	CONN, CABLE, RCP, 5 PIN	27264	09-50-7051
Q1	200200	TRANS NPN	21793	200200
R1	000103	RES CARBON 10 K 5% 1/4 W	81349	RC07GF103J
R2	000103	RES CARBON 10 K 5% 1/4 W	81349	RC07GF103J
R3	000103	RES CARBON 10 K 5% 1/4 W	81349	RC07GF103J
R4	000131	RES CARBON 130 OHM 5% 1/4 W	81349	RC07GF132J
R5	000392	RES CARBON 3.9 K 5% 1/4 W	81349	RC07GF392J
R6	000103	RES CARBON 10 K 5% 1/4 W	81349	RC07GF103J
R7	000103	RES CARBON 10 K 5% 1/4 W	81349	RC07GF103J
T1	300101	TRANSFORMER, POWER, GPIB	25159	F4X-044
TP1	600786	POST, MACHINE APPLIED STRIP	00779	85863-4
TP2	600786	POST, MACHINE APPLIED STRIP	00779	85863-4
TP3	600786	POST, MACHINE APPLIED STRIP	00779	85863-4
TP4	600786	POST, MACHINE APPLIED STRIP	00779	85863-4
TP5	600786	POST, MACHINE APPLIED STRIP	00779	85863-4
U1	230518	IC CMOS HEX INVERTING BUFFER	27014	MM80C98N
U2	230466	IC CMOS QUAD NAND GATE CD4011A	02735	CD4011A
U3	230624	IC CMOS DUAL D FLIP FLOP	27014	CD4013BNC
U4	230193	IC QUAD, NAND GATE	01295	SN74LS00N
U5	230306	IC QUAD, 2 INPUT NOR GATES	01295	SN74LS02
U6	230624	IC CMOS DUAL D FLIP FLOP	27014	CD4013BC
U7	230623	IC QUAD GPIB TRANSCEIVER	01295	MC3446N, J
U8	230623	IC QUAD GPIB TRANSCEIVER	01295	MC3446N, J
U9	230459	IC OCTAL GPIB TRANS SN75160	01295	SN75160

401681 - Assy. PCB, GPIB

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
U10	230635	IC MICROCOMPUTER, 8748-U10	21793	230635
U11	230275	IC REGULATOR	04713	MC7805CT
Y1	920840	CRYSTAL 3.579 MHZ		1107863-1
30	411681	PC BOARD, GPIB, UNSTUFFED	21793	411681
32	454564	NUT PLATE	21793	454554
33	454591	BRKT, HEATSINK	21793	454591
35	500117	WIRE, TEFLON, STRANDED 20G GRN		
38	600823	CONN, DIP, RECPT., 40 PIN		
41	601095	TERMINAL, CRIMP, SLIP-ON 18-24 GA		
42	601099	CABLE ASSY, INTERCONNECT		
43	610273	SPACER, SWAGE .062P x .125L x .250D		
44	610777	TIE, CABLE, LOCKING, .062-.750		
45	610899	TIE, CABLE, LOCKING, .062-2.00		
48	615044	SCREW, PHILLIPS PAN HD 4-40 X .375		
49	615059	SCREW, PHILLIPS PAN HED 6-32 X .375		
51	617017	NUT, HEX 6-32		
52	617016	NUT, RADIO HEX 4-40		
53	617051	WASHER, LOCK #4		
54	617128	WASHER, SPLIT LOCK #6		

MP MASTER
MA25719